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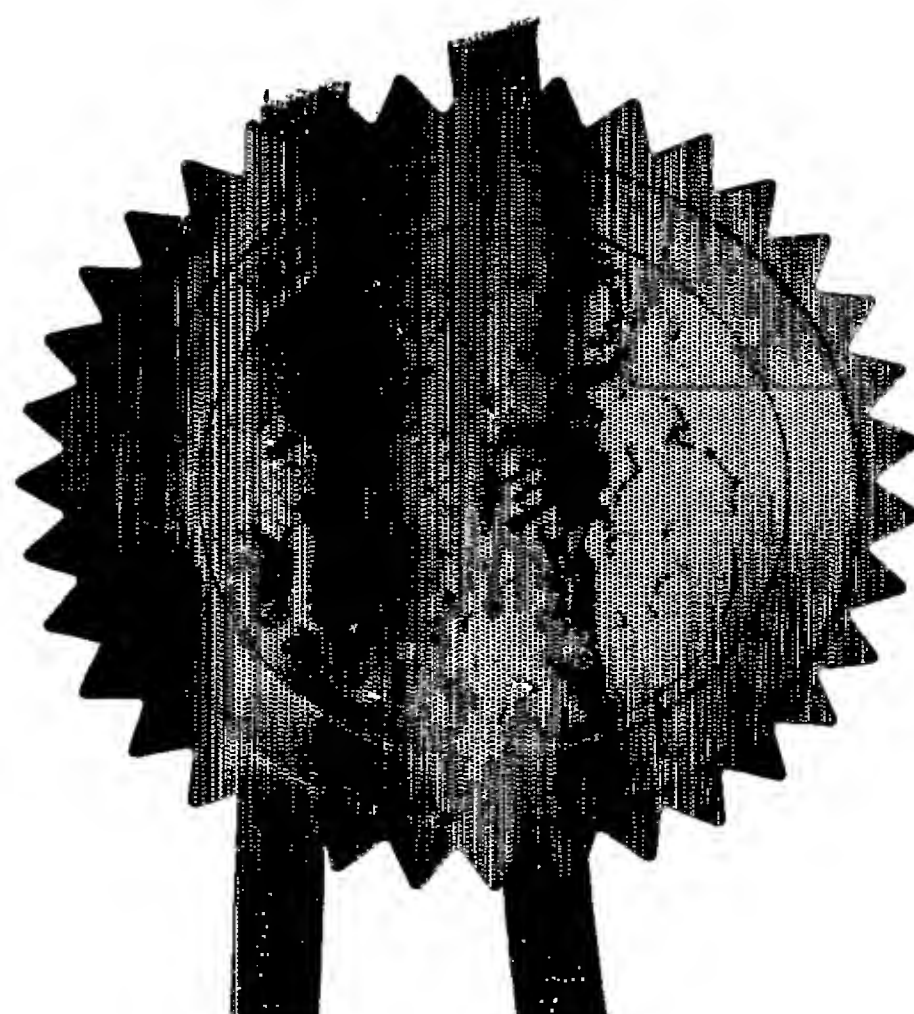
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GB 0407163.5

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[ADP No. 08940447001]



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2. Patent application number

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30 MAR 2004

3. Full name, address and postcode of the or of each applicant (underline all surnames)

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Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

SECTION 30 (1977 ACT) APPLICATION FILED 27/8/04
7928138001

4. Title of the invention

WATER-BASED METAL TREATMENT COMPOSITION

5. Name of your agent (if you have one)

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"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

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Country

Priority application number
(if you know it)

Date of filing
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Number of earlier application

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11.

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Paul G

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WATER-BASED METAL TREATMENT COMPOSITION

FIELD OF THE INVENTION

5 The present invention relates to a water-based composition that can be used for the treatment of a metal which may be a silver alloy but which may also be another metal requiring surface treatment to impart tarnish resistance e.g. copper, brass or nickel.

10 BACKGROUND TO THE INVENTION

Silver alloys and their tarnish-resistance

15 Standard Sterling silver provides manufacturers and silversmiths with a versatile and reliable material but it is inevitable that finished articles will require further cleaning and polishing to temporarily remove undesired tarnish products. It is well-known that with exposure to everyday atmospheric conditions, silver and silver alloys develop a lustre-destroying dark film known as tarnish.

20 Since ancient times it has been appreciated that unalloyed 'fine' silver is too soft to withstand normal usage, and it has been the practice to add a proportion of a base metal to increase hardness and strength. In the UK, legislation that has existed since the fourteenth century specifies a minimum silver content of articles for sale at 92.5% (the Sterling standard), but does not specify the base metal constituents.

25 Experience convinced early silversmiths that copper was the most suitable of the metals available to them. Modern silver-sheet manufacturers generally adhere to this composition, although sometimes a proportion of copper is replaced by cadmium to attain even greater ductility. Sterling with a 2.5% cadmium content is a standard material for spinning and stamping. Lower grades of silver alloys are common in

30 many parts of Europe for the production of hollow-ware and cutlery. The 800-grade alloys (Ag parts per thousand) are predominantly used in southern and mid-Europe whereas in Scandinavia the 830 standard is predominant.

In all but the largest manufacturing companies, most of the annealing and soldering required to assemble finished or semi-finished articles is carried out with the flame of an air-gas blowtorch. The oxidising or reducing nature of the flame and the temperature of the articles are controlled only by the skill of the silversmith. Pure silver allows oxygen to pass easily through it, particularly when the silver is heated to above red heat. Silver does not oxidise in air, but the copper in a silver/copper alloy is oxidised to cuprous or cupric oxide. Pickling of the oxidised surface of the article in hot dilute sulphuric acid removes the superficial but not the deeper-seated copper oxide so that the surface consists of fine or unalloyed silver covering a layer of silver/copper oxide mixture. The pure silver is easily permeated during further heating, allowing copper located deeper below the surface to become oxidised. Successive annealing, cold working and pickling produces a surface that exhibits the pure lustre of silver when lightly polished but with heavier polishing reveals dark and disfiguring stains known as 'firestain' or 'fire'. Soldering operations are much more productive of deep firestain because of the higher temperatures involved. When the depth of the firestain exceeds about 0.025mm (0.010 inches) the alloy is additionally prone to cracking and difficult to solder because an oxide surface is not wetted by solder so that a proper metallurgical bond is not formed.

20

Patent GB-B-2255348 (Rateau, Albert and Johns; Metaleurop Recherche) disclosed a novel silver alloy that maintained the properties of hardness and lustre inherent in Ag-Cu alloys while reducing problems resulting from the tendency of the copper content to oxidise. The alloys were ternary Ag-Cu-Ge alloys containing at least 92.5 wt% Ag, 0.5-3 wt% Ge and the balance, apart from impurities, copper. The alloys were stated to be stainless in ambient air during conventional production, transformation and finishing operations, to be easily deformable when cold, to be easily brazed and not to give rise to significant shrinkage on casting. They were also stated to exhibit superior ductility and tensile strength and to be annealable to a required hardness. Germanium was stated to exert a protective function that was responsible for the advantageous combination of properties exhibited by the new alloys, and was in solid solution in both the silver and the copper phases. The

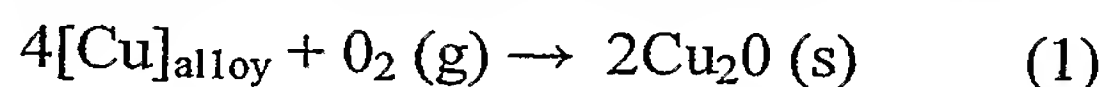
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microstructure of the alloy was said to be constituted by two phases, a solid solution of germanium and copper in silver surrounded by a filamentous solid solution of germanium and silver and copper. The germanium in the copper-rich phase was said to inhibit surface oxidation of that phase by forming a thin GeO or GeO₂ protective coating which prevented the appearance of firestain during brazing and flame annealing which results from the oxidation of copper at high temperatures. Furthermore the development of tarnish was appreciably delayed by the addition of germanium, the surface turned slightly yellow rather than black and tarnish products were easily removed by ordinary tap water. The alloy was said to be useful *inter alia* in jewellery. However, the alloy disclosed in the above patent suffers limitations insofar as it can exhibit large grain size, leading to poor deformation properties and formation of large pools from low-melting eutectics resulting in localised surface melting when the alloy is subject to the heat of an air torch.

Patents US-A-6168071 and EP-B-0729398 (Johns) disclose a silver/germanium alloy which comprised a silver content of at least 77 wt % and a germanium content of between 0.4 and 7%, the remainder principally being copper apart from any impurities, which alloy contains elemental boron as a grain refiner at a concentration of more than 0ppm and less than 20ppm. The boron content of the alloy can be achieved by providing the boron in a master copper/boron alloy having 2 wt % elemental boron. It was reported that such low concentrations of boron surprisingly provide excellent grain refining in a silver/germanium alloy, imparting greater strength and ductility to the alloy compared with a silver/germanium alloy without boron. The boron in the alloy inhibits grain growth even at temperatures used in the jewellery trade for soldering, and samples of the alloy were reported to have resisted pitting even upon heating repeatedly to temperatures where in conventional alloys the copper/germanium eutectic in the alloy would melt. Strong and aesthetically pleasing joints between separate elements of the alloy can be obtained without using a filler material between the free surfaces of the two elements and a butt or lap joint can be formed by a diffusion process or resistance or laser welding techniques. Compared to a weld in Sterling silver, a weld in the above-described alloy has a much smaller average grain size that improved the formability

and ductility of the welds, and an 830 alloy has been welded by plasma welding and polished without the need for grinding.

5 Ternary and quaternary alloys e.g. Ag-Cu-Ge alloys and Ag-Cu-Zn-Ge alloys include two base metal alloying elements, Cu and Ge, in a noble parent metal, Ag. On exposure to an oxidising atmosphere, two oxidation reactions have to be considered. Firstly, the oxidation of copper to cuprous oxide:



Secondly, the oxidation of germanium to germanium (di)oxide:



The above equation shows formation of germanium (IV) oxide, GeO_2 , but there may also be formed germanium (II) oxide, GeO or an intermediate material Ge_xO_y where x is 1 and y is greater than 1 but less than 2. Under standard conditions, i.e. for pure Cu and pure Ge each reacting with pure oxygen gas at 1 atm pressure to form the
15 pure oxide phase, both reactions are feasible, with the chemical driving force for reaction (2) being higher than that of reaction (1) by a factor of 1.65.

According to WO 02/095082 (Johns) tarnish resistance of ternary alloys of silver, copper and germanium or quaternary alloys of silver, copper, zinc and
20 germanium can be increased by casting a molten mixture to form the alloy and annealing the alloy to reduce its thickness and re-crystallize the grains in the alloy, the annealing being carried out under a selectively oxidizing atmosphere e.g. $\text{H}_2/\text{H}_2\text{O}$ or CO/CO_2 to promote the formation of GeO_2 while preventing the formation of Cu_2O .

25

Treatment compositions for removing or preventing silver tarnish

Various proposals have been made for cleaning or protecting Sterling silver and other known grades of silver to remove tarnish and/or to inhibit the formation of
30 tarnish.

US-A-2841501 discloses a silver polish based on an abrasive powder and a C₁₂-C₂₀ n-alkane thiol which is said to be non-toxic, to have a mild odor and to protect silver against tarnishing by forming a monomolecular layer R-S-Ag wherein R represents the alkane chain of the thiol, said layer forming a physical barrier
5 between the silver and reactive ingredients of the atmosphere.

GB-A-1130540 is concerned with the protection of a finished surface of Sterling or Britannia silver as a step in a production run, and discloses a process that comprises the steps of:

10 wetting a clean silver surface of an article with a solution comprising 99 parts by weight of a volatile organic solvent, for example trichloroethylene or 1,1,1-trichloroethane and from 0.1-1.8 parts by weight of an organic solute containing a -SH group and capable of forming a transparent colourless protective layer on the silver surface, for example stearyl and cetyl mercaptan or thioglycollate;

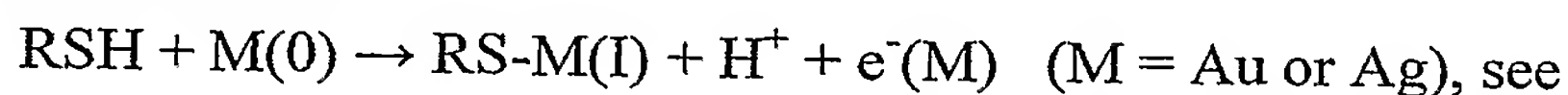
15 allowing the solution to react with the surface to form such a layer and allowing the solvent to evaporate; and

washing the surface with a detergent solution, rinsing the surface with hot water and allowing it to dry. The above process is stated to provide a "long-term finish" intended to last the intended shelf-life until the article reaches the user.
20 Halohydrocarbons were said to be the most suitable solvents but their suitability on environmental grounds is now open to question. Ethers were said to be flammable and toxic, and lower alcohols were said to be poor solvents. Water is not mentioned as a solvent. Applicants have seen a report on the Internet from ATOFINA Chemicals Inc that the solubility of mercaptans in water decreases progressively
25 from 23.30 g/litre for methyl mercaptan to 0.00115 g/litre for nonyl mercaptan, and data for for both hexadecyl and octadecyl mercaptan (CAS 2885-00-9) reports them as water- insoluble.

US-A-6183815 (Enick) also teaches that treatments of the above kind are
30 result in the formation of a self-assembled coating derived from the thiol compounds in which the sulphur atoms are bound onto the metal surface and the alkyl tails are directed away from the metal surface. In the examples of that specification,

fluoroalkyl amides e.g. $\text{CF}_3(\text{CF}_2)_5\text{CONH}(\text{CH}_2)_2\text{SH}$ in aqueous alcohols e.g. aqueous isopropanol are sprayed onto the surface of silver, after which the surface is rinsed and dried with a soft cloth. The fluoroalkyl amides lack detectable odour and can dissolve in lower alcohols or alcohol/water mixtures, although it is apparent from the description and examples that not all alcoholic solvents produce good films.

Yousong Kim *et al* report that the adsorption of thiols onto silver proceeds through an anodic oxidation reaction that produces a shift of the open circuit potential of the substrate metal in the negative direction or if the potential is fixed an anodic current peak:



<http://www.electrochem.org/meetings/past/200/abstracts/symposia/h1/1026.pdf>

Kwan Kim, *Adsorption and Reaction of Thiols and Sulfides on Noble Metals*, Raman SRS-2000, 14-17 August 2000, Xaimen, Fujian, China, <http://pcoss.org/icorsxm/paper/kuankim.pdf>, also discloses the formation of self-assembled monolayers and discloses that alkanethiols, dialkyl sulfides and dialkyl disulfides self-assemble on silver surfaces with aliphatic dithiols forming dithiolates by forming two Ag-S bonds.

In contrast, the literature on formation of alkylthiols of germanium is relatively sparse. The dissociative adsorption of H_2S at a Ge 100 surface to yield adsorbed $-\text{SH}$ groups and adsorbed hydrides has been reported by Nelen *et al.*, *Applied Surface Science*, **150**, 65-72 (1999), see <http://www.chem.missouri.edu/Greenlief/pubs/00005797.pdf>, see also a report by Professor Michael Greenlief of the University of Missouri-Columbia <http://www.chem.missouri.edu/Greenlief/Research.html> that room temperature exposure of H_2S to Ge(100) results in dissociative adsorption that can be followed easily by ultraviolet photoelectron spectroscopy. The reaction of alkanethiols with Ge to form a high quality monolayer has been reported in the context of semiconductor and nanotechnology by Han *et al.*, *J. Am. Chem. Soc.*, **123**, 2422 (2001). In the experiment described, a Ge(111) wafer is sonicated in acetone to

dissolve organic contaminants and immersed in concentrated HF to remove residual oxide and produce a hydrogen-terminated surface, after which the wafer is immersed in an alkanethiol solution in isopropanol, sonicated in propanol and dried.

5

SUMMARY OF THE INVENTION

The applicants have unexpectedly discovered that the treatment agents can be dissolved or dispersed directly in aqueous surfactant without the need for preliminary dissolving of the treatment agent in an organic solvent and subsequent mixing of the
10 resulting solution with aqueous liquid. The resulting solutions are useful for the treatment of Argentium silver, but may find use as treatment solutions or polishes for conventional Sterling silver and other metals subject to surface deterioration e.g. copper, brass and nickel. Embodiments of the above compositions are optically clear and storage-stable at ambient temperatures for a period of weeks or months.

15

In a further aspect, therefore, the invention comprises a water-based composition for treating a metal, comprising a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide and at least one of an amphoteric, nonionic or cationic surfactant in a concentration that is effective
20 to solubilise the treatment agent.

25

In a yet further aspect, the invention provides a method for manufacturing a water-based composition as aforesaid which comprises directly dissolving or dispersing the treatment agent in water containing the amphoteric, nonionic or cationic surfactant in a concentration that is effective to solubilise the treatment agent, and optionally further diluting the resulting solution or dispersion.

DETAILED DESCRIPTION OF THE INVENTION

30 Silver-copper-germanium alloys

The alloys that may be treated according to the invention include an alloy of silver containing an amount of germanium that is effective to reduce firestain and/or

tarnishing. US-A-6406664 (Diamond) discloses that amounts of germanium as low as 0.1wt% can be effective provided that substantial amounts of tin are present but although formulation examples are given, no test data for corrosion or firestain is given either for articles made by casting or for articles fabricated from sheet. The
 5 inventor considers that 0.5 wt% Ge provides a preferred and more realistic lower limit and that in practice use of less than 1wt% is undesirable. A two-component copper-free alloy could comprise 99% Ag and 1 % Ge, and a tarnish-free casting alloy for jewellery has been reported that comprises 2.5%Pt, 1% Ge, balance Ag and optionally containing Zn, Si or Sn.

10

The ternary Ag-Cu-Ge alloys and quaternary Ag-Cu-Zn-Ge alloys that can suitably be treated by the method of the present invention are those having a silver content of at least 30%, preferably at least 60%, more preferably at least 80%, and most preferably at least 92.5%, by weight of the alloy, up to a maximum of no more
 15 than 98%, preferably no more than 97%. The germanium content of the Ag-Cu-(Zn)-Ge alloys should be at least 0.1%, preferably at least 0.5%, more preferably at least 1.1%, and most preferably at least 1.5%, by weight of the alloy, up to a maximum of preferably no more than 6.5%, more preferably no more than 4%.

20

If desired, the germanium content may be substituted, in part, by one or more elements which have an oxidation potential selected from Al, Ba, Be, Cd, Co, Cr, Er, Ga, In, Mg, Mn, Ni, Pb, Pd, Pt, Si, Sn, Ti, V, Y, Yb and Zr, provided the effect of germanium in terms of providing firestain and tarnish resistance is not unduly adversely affected. The weight ratio of germanium to substitutable elements may
 25 range from 100: 0 to 60: 40, preferably from 100: 0 to 80: 20. Preferably, the germanium content consist entirely of germanium, i. e. the weight ratio is 100: 0.

30

The remainder of the ternary Ag-Cu-Ge alloys, apart from impurities and any grain refiner, will be constituted by copper, which should be present in an amount of at least 0.5%, preferably at least 1%, more preferably at least 2%, and most preferably at least 4%, by weight of the alloy. For an '800 grade' ternary alloy, for example, a copper content of 18.5% is suitable. The remainder of the quaternary Ag-

Cu-Zn-Ge alloys, apart from impurities and any grain refiner, will be constituted by copper which should be present in an amount of at least 0.5%, preferably at least 1%, more preferably at least 2%, and most preferably at least 4%, by weight of the alloy, and zinc which should be present in a ratio, by weight, to the copper of no more than 1: 1. Therefore, zinc is optionally present in the silver-copper alloys in an amount of from 0 to 100 % by weight of the copper content. For an '800 grade' quaternary alloy, for example, a copper content of 10.5% and zinc content of 8% is suitable.

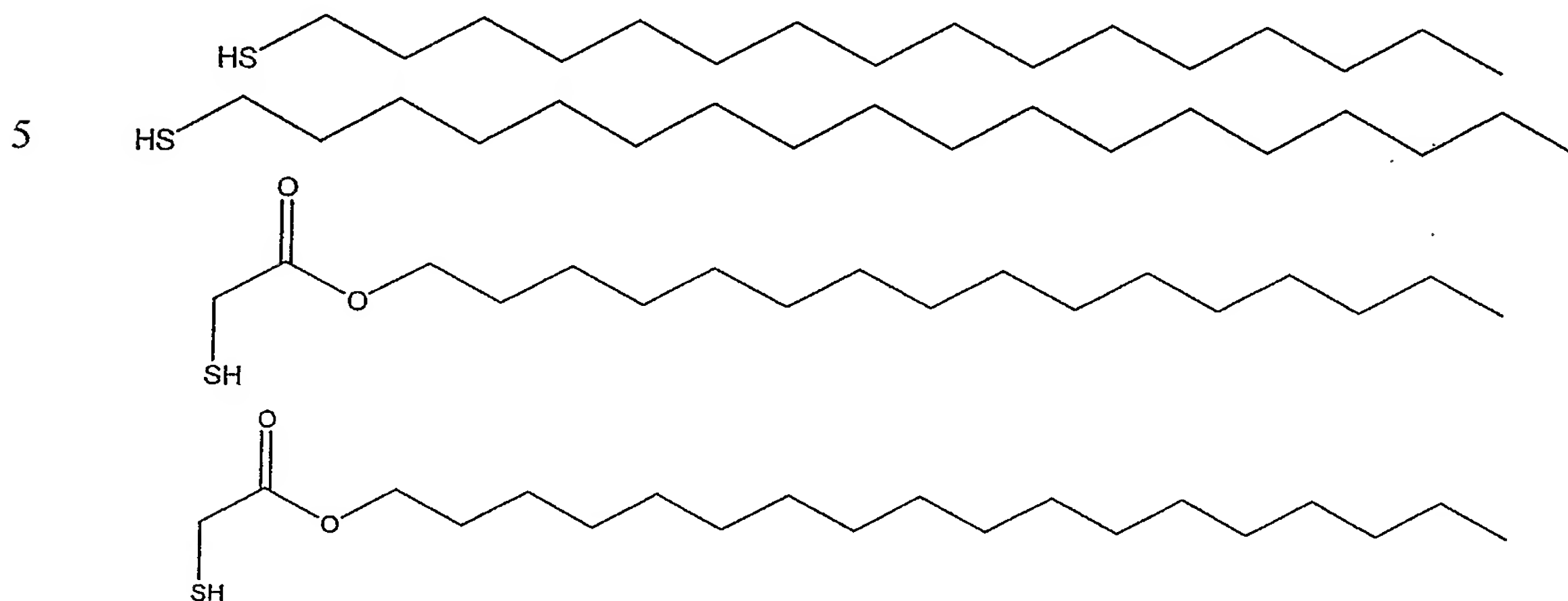
In addition to silver, copper and germanium, and optionally zinc, the alloys preferably contain a grain refiner to inhibit grain growth during processing of the alloy. Suitable grain refiners include boron, iridium, iron and nickel, with boron being particularly preferred. The grain refiner, preferably boron, may be present in the Ag-Cu-(Zn)-Ge alloys in the range from 1 ppm to 100 ppm, preferably from 2 ppm to 50 ppm, more preferably from 4 ppm to 20 ppm, by weight of the alloy.

In a preferred embodiment, the alloy is a ternary alloy consisting, apart from impurities and any grain refiner, of 80% to 96% silver, 0.1 % to 5% germanium and 1 % to 19.9% copper, by weight of the alloy. In a more preferred embodiment, the alloy is a ternary alloy consisting, apart from impurities and grain refiner, of 92.5% to 98% silver, 0.3% to 3% germanium and 1% to 7.2% copper, by weight of the alloy, together with 1 ppm to 40 ppm boron as grain refiner. In a further preferred embodiment, the alloy is a ternary alloy consisting, apart from impurities and grain refiner, of 92.5% to 96% silver, 0.5% to 2% germanium, and 1% to 7% copper, by weight of the alloy, together with 1 ppm to 40 ppm boron as grain refiner.

Protective agents

As protective agent there may be used a compound containing a long chain alkyl group and a -SH or -S-S- group, e.g. an alkanethiol, dialkyl sulfide or dialkyl disulfides in which the chain is preferably at least 10 carbon atoms long and may be C₁₂-C₂₄. The -SH or -S-S- compounds that may be used include straight chain saturated aliphatic compounds containing 16-24 carbon atoms in the chain, for

example cetyl mercaptan (hexadecyl mercaptan) and stearyl mercaptan (octadecyl mercaptan) and cetyl and stearyl thioglycollates whose formulae appear below.



10 Octadecyl mercaptan is a white to pale yellow waxy solid that is insoluble in water and that melts at 15-16°C. Hexadecyl mercaptan is also a white or pale yellow waxy solid that melts at 30°C.

Formulations based on aqueous liquids

15 It has surprisingly been found that formulations containing effective amounts of the treatment agents can be made by dissolving them directly in aqueous liquids containing an amphoteric, nonionic or cationic surfactant band free from water-immiscible organic solvents and preferably free from all other solvents. The treatment agents may be dissolved in relatively concentrated surfactant-containing
20 aqueous liquids, which may be used as such or after subsequent dilution with water.

25 A further aspect of the invention therefore provides a water-based composition for treating a metal, comprising a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide and at least one of an amphoteric, nonionic or cationic surfactant in a concentration that is effective to solubilise the treatment agent.

Thus one combination of materials that may advantageously be used comprises a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide, an anionic surface active agent and an amphoteric surface active agent in concentrations that are effective to solubilise the treatment agent.

A further combination of materials that may be used comprises a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide, an anionic surface active agent and a neutral surface active agent in concentrations that are effective to solubilise the treatment agent.

A yet further combination of materials that might be used comprises an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide, a neutral surface active agent and a cationic surface active agent in concentrations that are effective to solubilise the treatment agent.

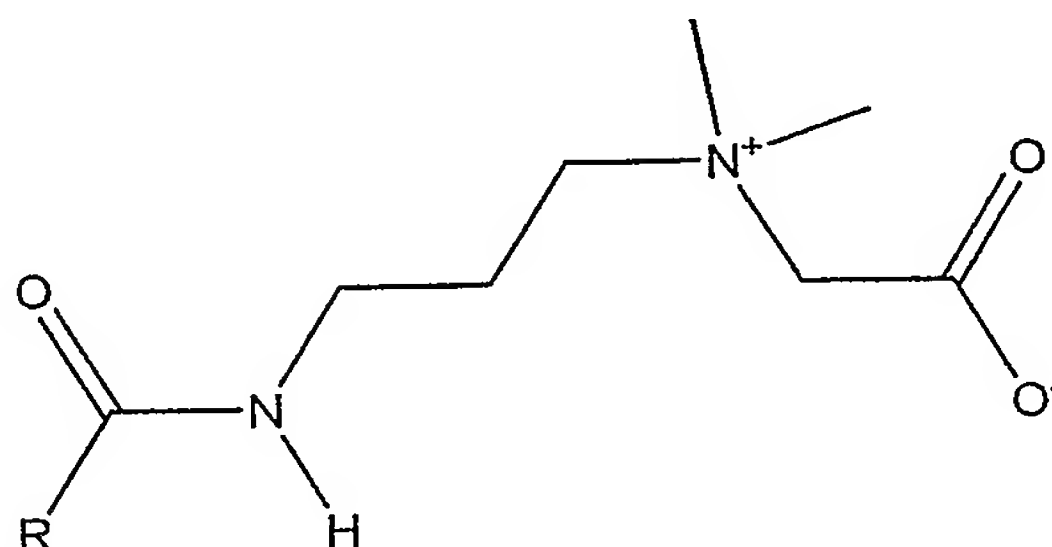
The treatment agent may be present in said composition, prior to dilution thereof, in an amount of at least 0.1 wt % and preferably at least 1 wt %, the solids content of the composition being at least 5 wt %, typically 10-40 wt % and possibly 50 wt% or more. The ability of aqueous surfactant liquids to dissolve or disperse such relatively high concentrations of higher alkyl thiols and other treatment agents which are reported to be highly water-insoluble has not been described. The resulting concentrates may be diluted with water to provide an aqueous treatment dip or combined degreasing solution and dip for use as explained above, and it has been found that the treatment agent may remain in solution or suspension following such dilution and may remain effective for the surface treatment of silver-copper or silver-copper-germanium alloys and possibly other metals such as copper, brass and nickel where surface protection films may retard corrosion. Particularly good results from the stability and effectiveness standpoint may be obtained by mixing hexadecyl mercaptan (in the liquid state) straight into a surfactant "carrier" and using the solution as such or on subsequent dilution with water.

In particular, the present treatment agents can be successfully dispersed in aqueous liquids containing mixtures of neutral and anionic surfactants with the neutral surfactants providing e.g. about 33 wt% of the total surfactant present. Treatment agents that can be dispersed in such agents include n-hexadecyl thiol and n-octadecyl thiol. They can also be successfully dispersed in aqueous liquids containing mixtures of amphoteric or zwitterionic surfactants and anionic surfactants and such mixtures can provide relatively storage stable optically clear solutions with little or no tendency to re-precipitate the treatment agent. In that case the weight ratio of the amphoteric or zwitterionic surfactant to the anionic surfactant may be from 1:1.5 to 1.5:1, typically close to 1:1.

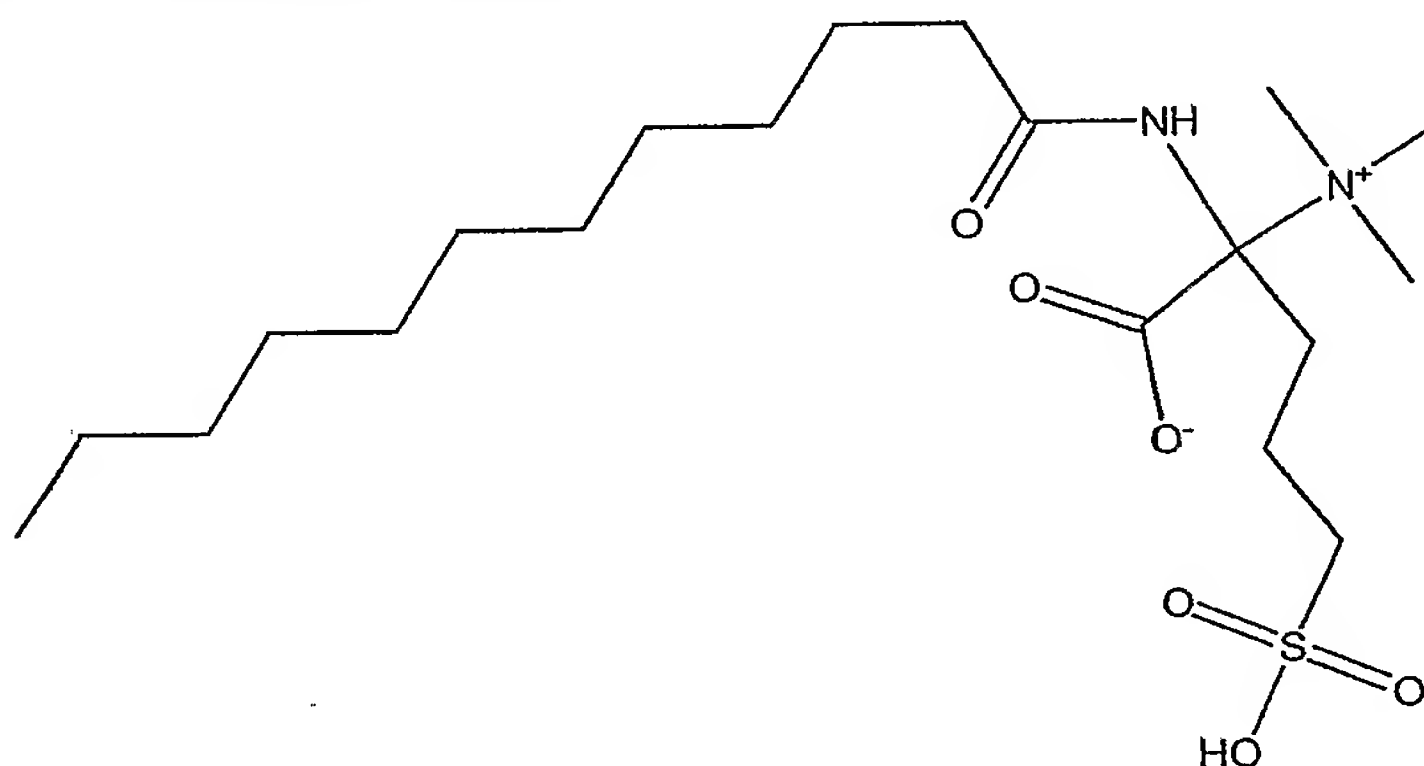
Amphoteric or zwitterionic surfactants that may be used alone or in admixture with one another and/or with nonionic surfactants and/or with anionic surfactants may be derivatives of secondary or tertiary amines, derivatives of heterocyclic secondary and tertiary amines, or derivatives of quaternary ammonium, quaternary phosphonium or tertiary sulfonium compounds. The cationic atom in the quaternary compound can be part of a heterocyclic ring. In all of these compounds there is at least one aliphatic group, straight chain or branched, containing from about 3 to 18 carbon atoms and at least one aliphatic substituent containing an anionic water-solubilizing group, e.g., carboxy, sulfonate, sulfate, phosphate, or phosphonate.

Examples of zwitterionic surfactants that may be employed include betaine surfactants, which are preferred, imidazoline-based surfactants, aminoalkanoate surfactants and iminodialkanoate surfactants. Suitable such surfactants include amidocarboxybetaines, such as cocoamidodimethylcarboxymethylbetaine, laurylamidodimethylcarboxymethylbetaine, cetylamidodimethylcarboxymethylbetaine, and cocoamido-bis-(2-hydroxyethyl)carboxymethylbetaine. Particularly preferred are amidocarboxybetaines of the formula below wherein R represents C₈-C₁₈ alkyl e.g. cocamidopropyl betaine. That compound is generally regarded as safe: in an Ames test conducted by BASF it did not prove mutagenic to Salmonella indicator organisms and in a human repeated patch insult

test (HRIPT) it did not indicate either contact hypersensitivity or photoallergy (see the MAFO CAB cocamidopropyl amino betaine data sheet published by BASF):



- 5 Also useful are sulphobetaine surfactants, e.g amido sulfbetaines such as lauramido-sulfopropylbetaine of formula indicated below,



- cocamido-2-hydroxypropylsulfobetaine, cocoamidodimethylsulfopropyl-betaine,
 stearyl-amido-dimethylsulfopropylbetaine, and laurylamido-bis-(2-hydroxyethyl)-
 10 sulfopropylbetaine. Also useful may be imidazoline-based surfactants including
 glycinate and amphotacetate compounds e.g. cocoamphocarboxypropionate,
 cocoamphocarboxypropionic acid, cocoamphocarboxyglycinate, and
 cocoamphoacetate, aminoalkanoate surfactants e.g. n-alkylamino-propionates and n-
 alkyliminodipropionates such as N-lauryl- β -amino propionic acid and salts thereof,
 15 and N-lauryl- β -imino-dipropionic acid and salts thereof.

Non-ionic surface-active agents that may be used alone or in admixture
 include compounds produced by the condensation of an alkylene oxide with an
 organic hydrophobic compound that may be aliphatic or alkyl aromatic. The length
 20 of the hydrophilic or polyoxyalkylene moiety that is condensed with any particular
 hydrophobic compound can be adjusted to yield a water-soluble compound having

the desired balance between hydrophilic and hydrophobic moieties. Semi-polar nonionic surface active agents may also be used, including amine oxides, phosphine oxides, and sulfoxides. Suitable classes of compound include:

- 5 • Polyethylene oxide condensates of alkyl phenols. These compounds include the condensation products of alkyl phenols having an alkyl group containing from about 6 to 12 carbon atoms in either a straight or branched chain, with ethylene oxide, the said ethylene oxide being present in amounts equal to 5 to 25 moles of ethylene oxide per mole of alkyl phenol. The alkyl substituent in such compounds may be derived, for example, from polymerized propylene,

10 diisobutylene, octene, or nonene.
- Condensation products of aliphatic alcohols with ethylene oxide. The alkyl chain of the aliphatic alcohol may either be straight or branched and generally contains from about 8 to about 22 carbon atoms.
- Condensation products of ethylene oxide with the product resulting from the

15 reaction of propylene oxide and ethylene diamine.
- Amine oxide surfactants, for example dimethyldodecylamine oxide, dimethyltetradecylamine oxide, ethylmethyltetradecylamine oxide, cetyldimethylamine oxide, dimethylstearylamine oxide, cetylethylpropylamine oxide, diethyldodecylamine oxide, diethyltetradecylamine oxide,

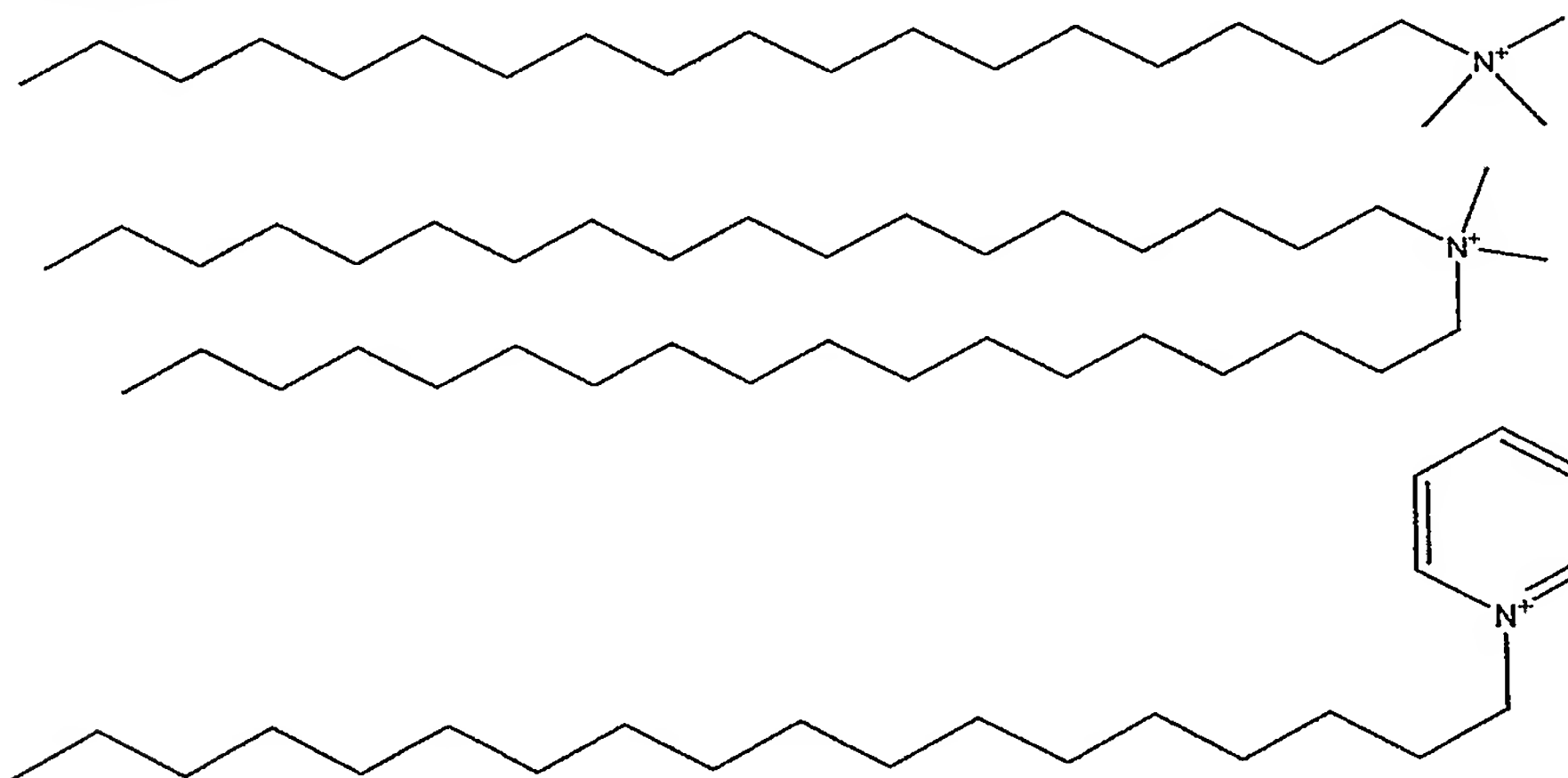
20 dipropyldodecylamine oxide, bis-(2-hydroxyethyl)dodecylamine oxide, bis-(2-hydroxyethyl)-3-dodecoxy-2-hydroxypropylamine oxide, (2-hydroxypropyl)methyltetradecylamine oxide, dimethyloleylamine oxide, dimethyl-(2-hydroxydodecyl)amine oxide, and the corresponding decyl, hexadecyl and octadecyl homologs of the above compounds.
- 25 • Phosphine oxide surfactants, e.g. dimethyldodecylphosphine oxide, dimethyltetradecylphosphine oxide, ethylmethyltetradecylphosphine oxide, cetyldimethylphosphine oxide, dimethylstearylphosphine oxide, cetylethylpropylphosphine oxide, diethyldodecylphosphine oxide, diethyltetradecylphosphine oxide, dipropyldodecylphosphine oxide,

30 dipropyldodecylphosphine oxide, bis-(hydroxymethyl)dodecylphosphine oxide, bis-(2-hydroxyethyl)dodecylphosphine oxide, (2-hydroxypropyl)methyltetradecylphosphine oxide, dimethyloleylphosphine oxide,

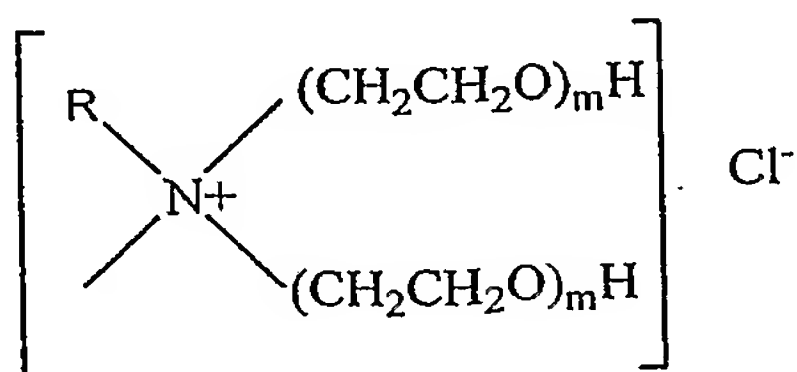
and dimethyl-(2-hydroxydodecyl)phosphine oxide and the corresponding decyl, hexadecyl, and octadecyl homologs of the above compounds.

- Sulfoxide surfactants, for example octadecyl methyl sulfoxide, dodecyl methyl sulfoxide, tetradecyl methyl sulfoxide, 3-hydroxytridecyl methyl sulfoxide, 3-methoxytridecyl methyl sulfoxide, 3-hydroxy-4-dodecoxybutyl methyl sulfoxide, octadecyl 2-hydroxyethyl sulfoxide, and dodecylethyl sulfoxide.
- Ethanolamide-based surfactants e.g. coconut fatty acid monoethanolamide or diethanolamide.

Cationic surfactants include quaternary ammonium compounds having one or two hydrophobic chains attached to the nitrogen atom and pyridinium compounds with a hydrophobic chain attached to nitrogen, the hydrophobic chain being e.g. up to C₄₀ alkyl, alkaryl or aralkyl, preferably about C₁₂-C₁₈, as in the cations below:



Representative compounds of the above types include alkylbenzyltrimethyl ammonium chloride, coconut alkylamine acetate, lauryl, cetyl or stearyl trimethyl ammonium chloride di-stearyl-dimethyl ammonium chloride, di-hydrogenated tallow dimethyl ammonium chloride (DHTDMAC), N-dodecyl pyridinium chloride and cetylpyridinium chloride. There may also be used polyethoxylated quaternary ammonium salts e.g. of formula



wherein R represents C₁₀-C₄₀, esp C₁₂-C₁₈ alkyl e.g. oleyl- or coco-. Further surfactants may be based on diethylene triamine (DETA)-based quaternaries, such as diamidoamine ethoxylates and imidazolines, and esterquats. As a class, esterquats can be based on compounds including methyl diethanolamine (MDEA),
 5 triethanolamine (TEA), and N,N-dimethyl-3aminopropane-1,2-diol (DMAPD).

A wide variety of alkyl sulfates may be used as anionic surface-active agents including fatty alcohol sulphates, fatty alcohol ether sulphates, alkyl phenol ether sulphates, alkyl aryl sulphonic acids and salts thereof, cumene, toluene and xylene
 10 sulphonates and salts thereof and alkyl sulphosuccinates e.g. sodium or ammonium lauryl sulfate. However, a preferred class of anionic surface active agents is polyol monoalkylether sulfates of the formula RO-(CH₂CH₂)_nSO₃M wherein R represents C₁₀-C₁₈ alkyl, n is 2-6 (preferably about 2-3) and M represents a monovalent cation. Such compounds are sulfonated ethoxylated C₁₀-C₁₈ alcohols which may be derived
 15 from coconut oil or tallow or may be synthetic. Sodium laureth sulfate which has been used successfully herein is a sodium lauryl ether sulphate ethoxylated to an average of two moles of ethylene oxide per mole of lauric acid and sulfated, and is of formula CH₃(CH₂)₁₀CH₂(OCH₂CH₂)₂OSO₃Na.

20 In addition to simple treatment agents, the above compositions may be formulated into metal polishes e.g. for silver or brass. Such products may be formulated as liquid products into which objects such as jewellery or cutlery are to be dipped. After dipping, the objects are usually rinsed under water and dried with a soft cloth. Alternative formulations take the form of creams or papes which are
 25 applied with a soft cloth and then removed.

For formulation into dipping compositions, the active ingredients are normally an acid having a pKa of not more than 5, e.g. phosphoric, citric, oxalic, or tartaric acid together with thiourea or a derivative thereof e.g. an alkyl derivative
 30 such as methyl or ethyl thiourea. For formulation into creams or pastes there may be e.g. about 25 wt% of a mild abrasive such as precipitated chalk, infusorial earth, silica or γ-alumina (e.g. 0.05 μm grade). These ingredients are believed compatible

with the surfactants and treatment agents and can be incorporated when convenient by simple mixing.

Treatment procedures

5

The surface treatment may be carried out after the manufacturing stages for a shaped article made of the alloy have been completed. The article may be of flatware, hollowware or jewellery. Fabrication steps may include spinning, pressing, forging, casting, chasing, hammering from sheet, planishing, joining by soldering
10 brazing or welding, annealing and polishing using buffs/mops and aluminium oxide or rouge.

An article to be treated may be de-greased by various methods:

- Vapour degreasing with or without ultrasonics
- 15 • Aqueous degreasing with or without ultrasonics
- Organic solvent degreasing with or without ultrasonics (e.g. degreasing with ethanol or acetone prior to thiol treatment which may provide very good accelerated tarnish test results)..
- Simultaneous degreasing and thiol treatment, the thiol being present in an organic
20 or aqueous degreasing medium.

For example, the article may be degreased ultrasonically in a treatment bath, dipped into a bath containing the treatment agent e.g. 1 wt% stearyl mercaptan in solvent e.g. EnSolv, rinsed in one or more baths of the solvent and allowed to dry by
25 evaporation. Rinsing excess thiol away with the same solvent that is used for thiol treatment is preferred, so that thiols that have not reacted with the metallic surface are removed and are unavailable to react with anything else. The solvent should leave no or substantially no residue, so that subsequent washing with water or aqueous solvents should be unnecessary and the article can be allowed to dry. The
30 article may then be packed for delivery into the distribution chain. This may include wrapping the article in one or more protective sheets, placing it in a presentation box, and wrapping the presentation box in a protective wrapping e.g. of heat-shrunk

plastics film. Articles which have been treated with an organic compound containing -SH or -S-S- groups as aforesaid and packaged should not only reach their point of sale in good condition but should if displayed e.g. on a shelf or in a cabinet for an extended period, expected to be at least 6 months and possibly 12 months or more, remain without development of significant tarnish.

The invention will now be further described, by way of illustration only, with reference to the following examples. Throughout the examples, the term "enhanced tarnish resistance" of samples treated with stearyl mercaptan refers to the comparison with samples of Argentium Silver which have not had any treatment except for polishing and degreasing.

Example 1

Hexadecyl and octadecyl mercaptan in Fairy liquid

Hexadecyl mercaptan (1g) in the liquid state was mixed with Fairy liquid (surfactant containing anionic and nonionic surface active agents) and with water in the quantities indicated below:

20

| Reference | Fairy liquid (ml) | Deionised water (ml) |
|-----------|-------------------|----------------------|
| 1.1 | 40 | Nil |
| 1.2 | 100 | Nil |
| 1.3 | 200 | Nil |
| 25 1.4 | 40 | 100 |
| 1.5 | 40 | 200 |

The ingredients of solution 1.2 appeared to mix well without needing the hexadecyl mercaptan to be dissolved in an organic solvent beforehand. A sample of Argentium silver was immersed in the resulting solution for 10 minutes and rinsed. The surface of the Argentium sample had become hydrophobic, suggesting the formation of a layer of hexadecyl mercaptan attached to the surface of the Argentium

silver. It rinsed well in water without any noticeable deposit being left on the surface after rinsing. A region of the sample was rubbed with cotton wool soaked in EnSolv 765 and then subjected to tarnish testing with neat ammonium polysulphide over a period of 45 minutes. Excellent tarnish resistance was noted, without significant difference between the region that had been treated with EnSolv 765 and the region that had not been so treated. Similar solutions were prepared from octadecyl mercaptan and Fairy liquid. They were transparent at first, but of lesser stability with separation of a surface layer of octadecyl mercaptan after some months.

Example 2

Hexadecyl mercaptan in Simple shower gel

Hexadecyl mercaptan in the liquid state was with Simple shower gel (a clear shower gel from Accentia Health and Beauty Ltd, Birmingham, UK, and believed to contain sodium laureth sulfate and cocamidopropyl betaine as principal surfactants, together with cocamide DEA and incidental ingredients) and with water in the quantities indicated below:

| Reference | HDM (g) | Simple (ml) | Deionised water (ml) |
|-----------|---------|-------------|----------------------|
| 2.1 | 1 | 100 | Nil |
| 2.2 | 1 | 100 | 100 |
| 2.3 | 5 | 100 | 100 |
| 2.4 | 1 | 200 | 100 |

25

Some days after mixing, solutions 2.1 and 2.4 were completely transparent viscous gels free from noticeable separation of the hexadecyl mercaptan. Sample 2.2 was also completely transparent but had a water-like consistency and again did not exhibit separation of hexadecyl mercaptan. Sample 2.3 which also had a water-like consistency appeared as a milky emulsion when shaken but exhibited separation of hexadecyl mercaptan at the surface on standing.

30

In a preliminary experiment, polished and degreased a sample of Argentium silver was immersed in solution 2.1 for 10 minutes and rinsed. The surface of the Argentium sample had become hydrophobic, suggesting the formation of a layer of hexadecyl mercaptan attached to the surface of the Argentium silver. It rinsed well in water and showed hydrophobic properties. When tested with neat ammonium polysulfide, excellent tarnish resistance was noted.

Samples of Argentium silver and conventional Sterling silver were prepared as follows. Each sample was polished with Steelbright polish, followed by rouge, and then ultrasonically degreased for two minutes in a 2 wt% Fairy liquid solution in water at 54°C. They were then further degreased for 5 minutes in ethanol and immersed at ambient temperatures in the test solution. After removal, part of each sample was rubbed with tissue soaked in EnSolv 765 and then subjected to tarnish testing with neat ammonium polysulphide over a period of 45 minutes. Argentium samples showed excellent tarnish resistance and thiol bonding, especially good results being obtained with solutions 2.1 and 2.4 compared to the higher water content solutions 2.2 and 2.3. Solutions 2.1 and 2.4 appeared to provide some tarnish protection for standard Sterling silver also, but the thiol layer could be removed easily as was apparent from the differences between the untreated and the EnSolv 765 treated regions.

Example 3

Mixtures of cocamidopropyl betaine (CPB) and sodium laureth sulfate (SLS)

The above materials were supplied as a thick pourable aqueous liquid and as a highly concentrated somewhat gelatinous liquid (70% active) by Surfachem Ltd of Leeds, United Kingdom. Hexadecyl mercaptan (1 ml) in the liquid state was mixed with these materials in the quantities indicated below:

| | Reference | SLS (ml) | CPB (ml) | Water (ml) |
|---|-----------|----------|----------|------------|
| | 3.1 | 40 | 40 | 100 |
| | 3.2 | 40 | 20 | 100 |
| 5 | 3.3 | 30 | 10 | 100 |
| | 3.4 | 10 | 30 | 50 |
| | 3.5 | 30 | 10 | 160 |

For solution 3.1, hexadecyl mercaptan was added to a thick mixture of sodium laureth sulphate and cocamidopropyl betaine after which water was added and the solution was mixed cold. The resulting mixture initially had a thick foamy-white texture which on settling turned into a transparent gel. Solution 3.2 was somewhat similar. Solution 3.3 was watery and was initially slightly transparent with lots of bubbles on top of the solution, and on settling overnight it became transparent. Solution 3.4 was mixed with gentle heating to about 35°C Heat appeared to slightly help with the mixing procedure. After a few minutes of mixing the mixture foamed severely. The mixture was allowed to stand overnight and formed a viscous solution. Solution 3.5 was heated to approximately 35°C whilst mixing. Water was last ingredient to be added. Using heat for mixing proved beneficial. The solution appeared very foamy but this settled over a few hours (within 12 hours) to form a transparent solution slightly thicker than water.

Argentium silver samples were prepared by polishing in Steelbright and then rouge, ultrasonically degreasing in a 2% aqueous Fairy Liquid solution further degreasing in acetone, immersion in the test solution at ambient temperatures for 10 minutes, and washing under cold running tap water. A lower region of each sample was rubbed with tissue soaked in EnSolv in an attempt to remove any thiols, after which the sample was left to stand for 45 minutes and were then exposed to a neat ammonium polysulphide accelerated tarnishing test for 45 minutes.

30

All the samples showed extremely good hydrophobic properties during the rinsing process, which indicates presence of thiols. Water drops were repelled and

there was no need to dry each sample. The samples performed well in the tarnishing test with resistance to tarnishing and little difference between the rubbed and un-rubbed regions. It was concluded that the hexadecyl mecaptan in each sample tested had created a tarnish-protective thiol-bonded layer on the surface of the Argentium
5 silver.

CLAIMS

1. A water-based composition for treating a metal, comprising a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide
5 and at least one of an amphoteric, nonionic or cationic surfactant in a concentration that is effective to solubilise the treatment agent.
2. The composition of claim 1, wherein the treatment agent is present in said composition, prior to dilution thereof thereof, in an amount of at least 0.1 wt%.
- 10 3. The composition of claim 1 or 2, wherein the treatment agent is present in said composition in amount of at least 1 wt%.
4. The composition of claim 1, 2 or 3, having a solids content of at least 5 wt %.
- 15 5. The composition of claim 1, 2 or 3, having a solids content of 10-40 wt %.
6. The composition of any preceding claim, wherein the treatment agent is hexadecyl mercaptan.
- 20 7. The composition of any preceding claim, comprising as surfactant a betaine.
8. The composition of claim 7, wherein the betaine is cocamidopropy betaine.
- 25 9. The composition of any preceding claim, further comprising an anionic surfactant.
- 30 10. The composition of claim 9, wherein the anionic surfactant is of the formula $\text{RO}-(\text{CH}_2\text{CH}_2)_n\text{SO}_3\text{M}$ wherein R represents $\text{C}_{10}\text{-C}_{18}$ alkyl, n is 2-6 and M represents a monovalent cation.

11. The composition of claim 9, wherein the anionic surfactant is a monovalent cation salt of laureth sulfate.
12. The composition of any preceding claim, comprising amphoteric or zwitterionic surfactant and anionic surfactant in a weight ratio of from 1:10 to 10:1.
13. The composition of any preceding claim, which is a polishing dip and further comprises an acid and a thiourea.
14. The composition of any of claims 1-12, which is a cream or paste polish further comprising a solid polishing medium.
15. The composition of claim 14, wherein the polishing medium is precipitated chalk, infusorial earth, silica or γ -alumina.
16. Use of the composition of any of claims 1-15 for the treatment of a silver-copper alloy, a silver-copper-germanium alloy, copper, brass or nickel.
17. A method of manufacturing a water-based composition comprising a treatment agent selected from an alkanethiol, alkyl thioglycollate, dialkyl sulfide or dialkyl disulfide and at least one of an amphoteric, nonionic or cationic surfactant, which method comprises directly dissolving or dispersing the treatment agent in water containing the amphoteric, nonionic or cationic surfactant in a concentration that is effective to solubilise the treatment agent, and optionally further diluting the resulting solution or dispersion with water.
18. The method of claim 17, wherein the treatment agent is dissolved in water containing a betaine surfactant and an anionic surfactant.
19. The method of claim 18, wherein the betaine surfactant is cocamidopropyl betaine and the anionic surfactant is sodium laureth sulfate.

20. The method of any of claims 17-19, further comprising incorporating an acid and a thiourea to produce a polishing dip.

21. The method of any of claims 17-20, further comprising incorporating a solid
5 polishing medium to produce a cream or paste polish.

22. The method of claim 21, wherein the polishing medium is precipitated chalk, infusorial earth, silica or γ -alumina.

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